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ABSTRACT

The use of computer graphics as visual aids to lecture-style university instruction is discussed briefly. It is contended that the following three factors inhibit the application of computers as visual aids: (1) the costs of providing sufficient numbers of monitors and large enough monitors to allow appropriate visual access by students are relatively high; (2) most software is designed for individualized, laboratory-style instruction as opposed to lecture hall instruction; and (3) teachers have negative attitudes toward the use of computers in the lecture hall. In spite of these problems, implementation of computers in lecture halls is likely to continue. Three original graphics screens developed for statistics lectures are cited. (TJH)

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# THE COMPUTER AS A VISUAL AID: POTENTIAL VERSUS REALITY

by

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# THE COMPUTER AS A VISUAL AID: POTENTIAL VERSUS REALITY

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Those of us in education like to think that computers were invented for us. Indeed, it may be true; Iowa State University was able to prove in a well publicized court proceeding that the first digital computer, albeit a special purpose device for solving simultaneous equations, was invented there rather than at IBM. If it is true that computers were invented by us and for us, then I find it rather ironic to note how minimally we use them in teaching!

This is not to say that computers have not been useful in higher education. Even if we discount their use for registration of students and sending out grades, computers have been of great help to teachers. This help, however has been almost solely limited to a supporting role, and not as a direct aid in the lecture hall.

## THE LIMITED USE OF COMPUTERS IN LECTURE HALLS

Many of us were present in the 1960's when multivariate analysis first became feasible with the behemoth mainframes and the BMD library. And we marveled when time-sharing enabled us to contact a GE mainframe in Chicago by using a telephone cradle on the Western Union terminal. And we certainly used their capabilities in education, if not in the lecture hall. In the early 1970's I put together a stylized interactive session with a fictitious computer person named "Hal, your friendly stat tutor" in which a student at a printing terminal was able to enter data into a regression algorithm and get not just a solution, but a lecture on intercepts, slopes, and correlation coefficients as well (Black, 1988). And many of us remember the early use of business simulations, and the devilish joy we felt in changing the interest rate in the middle of the game. My point is not that computers have not been used in education, because they certainly have. It is really rather amazing, however, with the computer revolution having been fought and won, that it has had little or no impact on our lectures.

Yes, there was the Hewlett Packard desktop machine (I think it was called the 9830) that could be hooked up to a plotter. I carried it to the classroom and had a good time fitting curves with a research class. But for the most part, the computer has been involved only in work assigned to be done outside of class. To facilitate the completion of these assignments, we have put millions of dollars into computer labs. Most of us are on our second and third generation of computer labs now (from the Apple II Plus to the first PC's to the PS/2's) and thousands and maybe

even millions of these outside-of-class assignments have been completed. My point remains this: isn't it ironic that this major advance in society, which we as academics invented, and which has had an impact on us as statisticians, has not yet been able to help us in our major work; that of delivering the material to the students in the lecture hall?

An article in the Journal of Computer-Based Instruction recently caught my eye (Duin, 1988). The title began "Computer-Assisted Instructional Displays...". Could this be the breakthrough into the classroom? Alas, my hopes were dashed after perusing the results of the investigation (which I always read first): it was determined that well designed CAI screens are better than poorly designed CAI screens, at the .05 level, n = 116. CAI, of course, means Computer Assisted Instruction, which in turn means one student at a lab computer station running a tutorial, one-on-one. I noticed another one with equally high hopes: the title included the words 'graphics', 'animation', and 'computer-assisted learning' (Baek and Layne, 1988). Once again it turned out to be applicable to a tutorial lab session.

Not that the research results were not interesting. The authors found that graphic screen designs resulted in student scores higher than those for text only, and that the addition of animation brought significantly higher scores yet! Could this be applicable to the lecture hall? Could it be possible that a graphics image projected from a PC screen would be better than words-only? And that animation in the lecture would be better yet?

Implications of the body of knowledge are plain: that visuals, in graphics, color, and animation, improve student comprehension (Salisbury, 1990; Hannafin, Dalton, and Hooper, 1988;Umanath and Scamell, 1988; Gillingham, 1988; Surber and Leeder, 1988). The possibility that this extends into the area of computer graphics as a substitute for the chalkboard, however, has not generally been considered.

Please note that this does not take anything away from the utility of computer use in the statistics lab. Athey (1987) achieved substantial increase in student ability to integrate knowledge and choose a correct statistical tool by using a tutorial. Publishers have concentrated recently on the inclusion of a data base and a statistical processor with their texts. Specialized statistical learning packages using graphical normal distributions include Adventures in Statistics and E Z Stat. Once again, however, they are not designed to be used in the classroom.

FACTORS LIMITING THE USE OF COMPUTERS AS VISUAL AIDS

It seems that there are three sorts of things that inhibit the application of computers as visual aids. Each of them applies to many classroom disciplines, including statistics. First, there is the hardware problem. While computers have been around for nearly forty years, computer screens are much more recent. The printed output from a Western Union terminal would hardly seem to be usable as a visual aid (I remember trying to convert it to a visual aid by pointing a video camera at the printed page and showing the results to the class on closed circuit television.) Even with the advent of large monitors, the resolution problems, together with the choice of only two character fonts (either 40-column or 80 column text), made their use difficult. The cost of the monitors was usually outside the budget anyway.

Projectors are even more expensive. The problem has not been only the expense, though. Image quality and brightness have been so poor that even a minor expense was deemed excessive! (Stafford, 1989) And has anybody tried to focus that green screen so the text can be read at the back of the room? Even worse is the problem of convergence. Red, green and blue are wonderful, but not if they project as shadows of each other, and older model projectors tended to forget their convergence settings regularly. If the projector was moved, then call the technician!

The LCD plate was supposed to solve all this. Just use the overhead projector, placing the LCD screen on it as though it is a transparency, and behold the projected image. Another one that can't be read at the back of the room. And the research regarding color and animation? LCD does not mean Low Calorie Diet, but it could stand for Low Color Discrimination. No red at all, just shades of purple. And not all that cheap either...around $1200. A new one is out now that is supposed to be able to project color, but the price is about $5000, almost enough for a good 30 inch monitor.

Secondly, most of the software that is available is designed for CAI (Computer Aided Instruction, as in a lab, one-on-one) and not for CAT (Computer Augmented Teaching, as a visual aid in the classroom). Distinctly different programming techniques are required for these two applications. CAI emphasizes drill and practice, tutorials, and simulations. Multiple choice tests can be taken. Records can be kept of individual student performance. During tutorials, the user can move backward or forward, repeating and reinforcing a concept, then choose to go on when ready. CAT applications, on the other hand, need to respond to the teacher, not the student. As the lecture progresses, the visuals need to be stopped and started, with explanations in between. Very little text is necessary, but graphics, especially statistical distributions, can be very

helpful. A remote keyboard capability enables the instructor to roam, ruminate, and control the display at the same time.

A glance at the Educom/NCRIPTAL awards for outstanding instructional software shows the leaning toward laboratory applications: the awards, without exception, go to software designed for a small computer screen in a laboratory setting. And even though "presentation graphics" seems to be a hot topic now, I generally find that what is meant by this phrase is bar charts, pie charts or line graphs. Authoring systems have been developed to aid the process of courseware development, but are usually oriented toward the creation of software for laboratory use.

Attitude is the third category of inhibiting factors. This has been cited as the greatest single hurdle to implementation of computers in education (Dalton, 1987). We as educators know of our weaknesses; among the most blatant is a tendency toward inertia. Change has always been difficult in academia, so we keep on lecturing. In the case of computer use, however, there is ample reason not to change. Consider the extensive self-inflicted pain and suffering in the adoption of a computer as a lecture aid. In a prior era when we wanted a movie, a call to ITV would suffice to have the movie projector taken to the classroom. The projector was self-loading, so the movie could become a part of the instruction with minimal trauma. Not so in the case of computer visuals. First, there is a substantial problem in finding applicable software. Next, the software must be placed on a floppy that is compatible with the portable version of the PC. Then the portable and the LCD plate must be checked out from the office, carried to the classroom (along with a briefcase), with the hope that the previous user left the battery charged. Upon arriving in class, it must be hooked up by plugging in the overhead projector, LCD plate, serial port, and power supply. Then boot the portable (if you haven't forgotten the DOS disk), and try to remember the alt-key combination to cause the monitor signal to be sent to the LCD screen. If all this is successful, class can begin, at least 10 minutes into the hour. Is there any wonder that our attitudes are affected, leading one researcher to conclude that computers have "yet to be tried on any large scale in instruction?" (Bork, 1986).

## TODAY'S REALITY IN COMPUTER AUGMENTED TEACHING

In spite of these problems, implementation of computers in lecture halls is likely to go forward. It has previously had potential: now its capabilities in both software and hardware have become reality. Harvey Hughett (1987) of the University of Idaho asks this question: "You can lead an old horse to water, but can you get him to use a computer?

The answer is a qualified 'yes'. At many universities the old "mediated classrooms" are now becoming "computer mediated"; that is, data projectors are being permanently installed in lecture halls. Many rooms even have built-in computer consoles, obviating the need to carry in a portable PC. When the hardware becomes generally available, software will follow. Attitudes will change; teachers will see and adopt the better methods.

A new phase of the computer revolution is upon us; it is called Multimedia. Products now available at reasonable prices expertly combine video, interactive computer overlays, and high fidelity sound to create learning packages (Poor, 1990-a; Rosch, 1990; Hofstetter, 1989). High quality projectors with VGA resolution and exceptional brightness are now available (Poor, 1990-b), and perhaps most important, budgets that once were completely spent in outfitting labs are now available to create computer augmented lecture halls.

With these realities and a good deal of luck, Hofstetter's dream may come true, and I quote:

> The computer-assisted instruction movement of the past decade provided students with powerful tools for improving learning on the desktop. Now it is the faculty's turn to use the computer to improve teaching and learning in the classroom." (Hofstetter, 1989)

## APPLICATION OF COMPUTER AUGMENTED TEACHING TO STATISTICS

I will now show some of the graphics screens I have developed for Statistics lectures. They include

Areas under the Normal Curve
Central Limit Theorem
Decision Rules and Error Tradeoffs.

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